



Irish Nurses and Midwives Organisation
Working Together

Safe Staffing: The Evidence

Key facts from a review of published research findings

IRISH NURSES AND MIDWIVES ORGANISATION

November 29, 2012

Safe staffing: The evidence

Key facts from a review of published research findings

Lower nurse staffing is associated with higher mortality

Research studies across the world have established a direct association between better nurse staffing and lower mortality rates among patients. Lower staffing associated with higher patient mortality has been identified in countries including USA, England, Switzerland, Belgium, China and Taiwan.

Lower nurse staffing is associated with other adverse events and poor care

Poor nurse staffing practices have been associated with increased incidence of a range of poor patient outcomes including increased rates of pneumonia, rates of urinary tract and surgical site infection and pressure ulcers.

Increased nursing hours per patient have been associated with reduced patient falls. One study also identified that a lower percentage of registered nurses on staff was associated with a higher rate of falls.

Inadequate staffing levels were identified by an independent Inquiry as a key contributing factor to the 'appalling' care experienced by patients at Mid Staffordshire NHS Foundation Trust.

Lower nurse staffing is associated with less effective and efficient care

Lower nurse staffing is associated with longer lengths of stay, as well as increased rates of readmission to hospital after discharge. Both readmission and longer lengths of stay increase healthcare costs.

A number of research studies have also identified that increasing the number of nurses with lower grade qualifications will not bring about the same care improvements as increasing the number of registered nurses. Similarly, poorer care outcomes have been associated with lower proportions of registered nurses in the staffing profile.

Lower nurse staffing is associated with higher fatigue and burnout

Poor staffing levels increase the risk of burnout amongst nurses. This in turn, increases the risk of poorer patient care.

A lack of time away from work and long work hours is also associated with poorer patient outcomes including higher mortality rates from pneumonia.

Case Study: Poor staffing a key factor in care failures at Mid Staffordshire NHS Foundation Trust

In March 2009 England's Healthcare Commission published a highly critical report about the standard of care being provided at Mid Staffordshire NHS Foundation Trust. The report highlighted significant failures in care, including mortality rates 'significantly higher than the average'. Press reports at the time estimated that between 400 and 1200 deaths were attributable to poor care.

A public outcry about both the standards of care and the failure of either internal management or external agencies to prevent and resolve the problem led the then Secretary for Health, Andy Burnham, to establish an Independent Inquiry in 2009. The Inquiry sought to 'learn from the appalling experiences suffered by such a large number of people' between 2005 and 2009.

An important finding of the Inquiry was that the period that was being investigated was characterized by cuts in staff and changes in skills ratios that, according to the report were 'motivated by a perceived need to save money (Francis 2010, p.230).

This echoed the earlier finding of the Healthcare Commission's (then known as the Commission of Healthcare Improvement) that 'staffing levels are a cause of concern, particularly in nursing'(Francis 2010, p.231) at Mid Staffordshire. Between 2005 and 2009, 1722 incident reports had been filed by staff in relation to staffing levels at the Trust (Heyes 2012).

The Inquiry report concluded that 'something must have gone seriously wrong for the Board to have permitted a substantial nursing workforce reduction at a time when the hospital was already under-staffed without an effective risk assessment' (Francis 2010, p.241).

Mortality

- A review of English language research, linking patient outcomes and nurse staffing levels published in 2010, found a 16% reduction in the risk of mortality in surgical patients with higher registered nurse staffing levels (Twigg et al. 2010).
- This was consistent with the findings of a 2007 review and meta-analysis of studies conducted in the USA and Canada which found that increased registered nurses staffing was associated with lower hospital related mortality in intensive care units, in surgical units and in medical patients [odds ratios of 0.91, 0.84 and 0.94 respectively, per every additional full time equivalent registered nurse per patient per day (Kane et al. 2007).
- A 2011 study found a significant association between increased mortality and low staffing. The study looked at the association between patient mortality and duration of nursing shifts during which registered nurse staffing was 8 hours or more below the staffing target, and involved analysis of nearly 200,000 admissions at a USA medical Centre (Needleman et al. 2011).
- A study of 30 hospital trusts in England found that hospitals in which nurses cared for the fewest patients had significantly lower surgical mortality and failure-to-rescue than those in which nurses cared for the greatest numbers of patients. There was a 26% difference in mortality risk between the highest and lowest staffing levels (Rafferty et al. 2007).
- Allowing for severity of illness and hospital characteristics, a study in Taiwan found that the incidence of death was much lower in groups where there was high nurse manpower than in groups with low nurse manpower (Y.-W. Liang et al. 2012).
- Analysis of hospital discharge and nursing minimum data sets in Belgium studied outcomes of over 9000 patients who had undergone coronary artery bypass surgery or heart valve procedures across 28 acute hospitals. It concluded that higher nurse staffing levels protected patients from in-hospital mortality (Diya et al. 2012).
- Research from Korea has found that in secondary hospitals, every additional patient per registered nurse (i.e. a lower nurse-patient ratio) was associated with a 9% increase in the odds of dying, regardless of the level of experience of the nurses (Cho et al. 2008).

The Institute of Medicine's (IOM) report "Keeping Patients Safe: Transforming the Work Environment of Nurses" (2004) estimated that low nurse staffing contributed to the estimated 98,000 preventable deaths each year in the USA attributable to errors in care.

- A 2002 study conducted in the USA found that for surgical patients, the risk of death increased by 7% for each additional patient over four in a nurse's workload. The same study found that patients with a patient to nurse ratio of eight patients to one nurse had a 31% greater risk of dying than those in hospitals with four patients per nurse (Department for Professional Employment 2003).
- An examination of outcomes from 665 hospitals in the USA published in 2011 found that decreasing the workload by 1 patient per nurse had a significant impact on deaths and failure to rescue in most hospitals. Those with a working environment rated as average showed a 5% increase, and those with the best working environment by 9 to 10%. There was no impact in hospitals with a poor working environment (Aiken et al. 2011).
- 'When we use the predicted probabilities of dying from our adjusted models to estimate how many fewer deaths would have occurred in New Jersey and Pennsylvania hospitals if the average patient-to-nurse ratios in those hospitals had been equivalent to the average ratio across the California hospitals, we get 13.9 percent (222/1,598) fewer surgical deaths in New Jersey and 10.6 percent (264/2,479) fewer surgical deaths in Pennsylvania (Aiken et al. 2010).

Other adverse events

- Analysis of a database on sentinel events reported to the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) found that nurse staffing levels are cited as one of the four major causal factors for reported serious errors/adverse events such as patient falls, medication and transfusion errors, delays in treatment, and operative and postoperative complications (Page 2004, p.48).
- Across a range of nurse-sensitive outcomes, Duffield et al found that increasing registered nurses hours by 10% could produce a decrease in the adverse event rates studies from 11% to 45% (C Duffield et al. n.d.).

Falls

- An additional registered nurse hour per day was associated with a 3% lower fall rate in ICUs in a 2010 review conducted in the USA. The study's findings also suggest that it is nursing, in particular, that made a positive difference, as an additional licensed practical nurse (LPN) or nursing assistant (NA) hour was associated with a 2-4% higher fall range in non-ICUs (Lake et al. 2010).
- A study examining data across 11 acute care hospitals found that nursing hours per patient day was negatively associated with patient falls, and that patient fall rates increased as the overall score for missed nursing care increased (Kalisch et al. 2012).
- A US study comparing the performance of Magnet¹ and non-Magnet hospitals in the US found that an additional registered nurse per patient day was associated with a 3% lower fall rate in ICUs (Lake et al. 2010).
- 'This study estimated the relationship between three aspects of nurse staffing and the patient fall rate for four types of acute care units. The association was estimated using a generalized linear mixed model with data for 2002 from 1751 hospital units in the National Database of Nursing Quality Indicators. Higher fall rates were associated with fewer nursing hours per patient day and a lower percentage of registered nurses, although the relationship varied by unit type (Nancy Dunton et al. 2004)'
- An analysis of data from the National Database of Nursing Quality Indicators TM (NDNQI^R) found that fall rates were associated with nursing care:
 - Fall rates were 1% lower for every one hour increase in total nursing hours per patient day
 - Fall rates were 0.7% lower for every increase of 1 percentage point in the percent of nursing hours supplied by registered nurses, and
 - Fall rates were 1% lower for every increase of a year in average registered nurse experience(NE Dunton et al. 2007).

¹ Magnet status is an award given by the American Nurses' Credentialing Center (ANCC), an affiliate of the American Nurses Association, to hospitals that satisfy a set of criteria designed to measure the strength and quality of their nursing. A Magnet hospital is stated to be one where nursing delivers excellent patient outcomes, where nurses have a high level of job satisfaction, and where there is a low staff nurse turnover rate and appropriate grievance resolution.

- A 2011 study of patient falls in military hospitals showed that ‘a greater proportion of registered nurses relative to unlicensed personnel was associated with fewer falls in medical-surgical units. Higher nursing care hours per patient per shift were significantly associated with a decreased likelihood of both fall and a falls with injury’ (Patrician, Loan, et al. 2011), (Berry & Curry 2012).

Pneumonia

- Needleman’s landmark study published in 2002 calculated the decrease in the range of hospital acquired pneumonias associated with increasing staffing of registered nurses from the 25th to the 75th percentile. The study used administrative data from 1997 in 799 hospitals in the USA, covering over 5 million discharges of medical patients and over 1 million discharges of surgical patients. The study found that increasing the proportion of registered nurses hours would decrease the rate of pneumonia by 6.4% and increasing the number of registered nurse hours per patient per day would decrease the rate of pneumonia by 2.7% (Needleman et al. 2002).
- A 2007 review of 28 studies reporting adjusted odds ratios found that an increase by 1 registered nurse per patient day was associated with decreased odds ratio of hospital acquired pneumonia of 0.70 (Kane et al. 2007).
- Another review published in 2007, conducted a pooled analysis identified a ‘significant and consistent reduction’ in the odds of hospital-acquired pneumonia: a 19% reduction in all patients and a 30% reduction in ICUs (Kane et al. 2007).
- A cohort study conducted in a Geneva hospital looking at outcomes for patients admitted between January 1999 and December 2002 found that a high nurse-to-patient ratio was associated with a decreased risk for late-onset ventilator-associated pneumonia (Hugonnet et al. 2007).
- A study examining 2004 data from acute hospitals in North Carolina and Illinois found that pneumonia deaths were significantly more likely in hospitals where nurses reported schedules with long work hours (odds ratio 1.42) and lack of time away from work (odds ratio 1.24) (Trinkoff et al. 2011)
- A study of 35 Swiss hospitals, conducted as part of the RN4CAST project, found that implicit rationing of nursing care resulted in a significant increase in pneumonia (odds ratio 2.672)(Ausserhofer et al. 2012).
- Analysis of data on patients from 20 surgically-related diagnostic groups in 232 California hospitals revealed that an increase of 1 hour worked by registered nurses per day was associated with an 8.9% decrease in the odds of pneumonia and that a 10% increase in the proportion of registered nurses was associated with a 9.5% decrease in pneumonia(Cho et al. 2003).

Urinary tract infection

- Needleman's study published in 2002, found increasing the proportion of registered nurses resulted in a 9.0% decrease in the rate of urinary tract infection (UTI) and an increase in the number of registered nurse hours per day per patient day resulted in a 3.6% decrease.

Medication error

- 'As the registered nurse hours per patient day increased, the medication errors decreased; conversely, as the licensed practical nurse (LPN) hours per patient day increased, the medication errors increased' (Frith et al. 2012).
- A study conducted as part of the RN4CAST project of hospitals in Switzerland found that there was a significant increase in the odds of nurse reported medication errors (OR=2.513) where there were higher levels of implicit rationing of nursing care (Ausserhofer et al. 2012).

Efficiency and effectiveness of health care

Length of Stay

- A 2007 review of 46 studies published between 1990 and 2006 found that the evidence reflected significant reductions in length of stay were possible with higher ratios of nursing personnel in hospital settings (Thungjaroenkul & Cummings 2007).
- Kane et. al reviewed 28 studies conducted in Canada and the US and found that an increase by 1 registered nurse per patient day was associated with the length of stay being shorter by 24% in ICUs and 31% in surgical patients (Kane et al. 2007).
- Tschannen and Kalisch collected data on nurse employment and patient characteristics in two hospitals in the American Midwest and found that increased nurse hours per patient day was a predictor of shorter than average length of stay (Tschannen & Kalisch 2008).
- Needleman(2002) found that increasing staffing of registered nurses from the 25th to the 75th percentile resulted in a 3.5% decrease in length of stay when the proportion of registered nurse hours was increased, and a 5.2% decrease in the length of stay when the number of registered nurse hours per patient day was increased (Needleman et al. 2002).
- A study examining medical and surgical patients in US nonfederal acute care hospitals including literature reviews and hospital discharge data, found that as nurse staffing levels increase, hospital length of stay decreases(Dall et al. 2009).

Readmissions

- Diya et al, in their study of 9054 patients who underwent coronary artery bypass surgery or heart valve procedures in Belgium found that higher nurse staffing levels on postoperative nursing cardiac surgery units protected patients from unplanned readmission to intensive care units or operating theatre and in-hospital mortality.”(Diya et al. 2012)
- A 2011 study found that an increase of 0.71 non-overtime registered nurse hours per patient day was associated with a 45% lower change of an unplanned emergency room visit after discharge. Conversely, a 0.08 increase in registered nurse overtime was associated with the odds of an unplanned emergency room visit after discharge increasing by one third (K. Bobay et al. 2011) cited in (Berry & Curry 2012).

Cost effectiveness

- A study published in 2009 used hospital discharge data to estimate the incidence of adverse patient outcomes. The study demonstrated association with lower nurse staffing levels to estimate the incidence of these outcomes and the associated cost. It found that as nursing levels increase, patient risk of nosocomial complications and hospital length of stay decreased, resulting in medical cost savings and improved national productivity (Dall et al. 2009).

Patient satisfaction

- A study across 430 hospitals in the United States found that increased patient-to-nurse workloads were significantly associated with higher patient ratings, recommendation of the hospital to others, and their satisfaction with the discharge information they received (Kutney-Lee et al. 2009).
- Higher levels of nurse 'rationing' in Switzerland was found to result in a significant decrease in the odds of patient satisfaction (OR=0.276) (Ausserhofer et al. 2012).
- Similar results were found in a study of Chinese hospitals, which found that patients in hospitals with better work environments and higher nurse-assessed safety grades were more likely to rate their hospital highly, be satisfied with nursing communications, and to recommend their hospitals (ORs ranging from 1.24 to 1.40)(You et al. 2012).

A sustainable health workforce

Work schedules, burnout and fatigue

- Controlling for staffing levels and staffing characteristics, lengthy work schedules were found to be significantly related to mortality in a 2004 survey of 633 US nurses. The study found that pneumonia deaths were more likely when nurses schedules meant long work hours and lack of time away from work (Trinkoff et al. 2011).
- A 2012 study found a significant association between patient-to-nurse ratio and infections of both the urinary tract and surgical sites. Further investigation found that this outcome was primarily associated with burnout, and that a 30% reduction in burnout was associated with a total of 6,239 fewer infections and an annual cost saving of \$68 million (Cimiotti et al. 2012).
- A study conducted in Taiwan found that although time pressure did not significantly affect patient safety, time pressure and burnout had an interactive effect. Where nurses had high burnout, time pressure was negatively related to patient safety (Teng et al. 2010).
- A study conducted in the USA found that each additional patient per nurse corresponded to a 23% increased risk of burnout, and a 15% decrease in job satisfaction (Department for Professional Employment 2003).
- Forty-two per cent of Irish nurses surveyed in 2010/2011 as part of the RN4CAST project (n=1,406) reported high levels of emotional exhaustion², a key component of burnout. The report notes that these levels are high by international standards: of the eight countries involved in the RN4CAST project, only Greek and English nurses reported higher rates of emotional exhaustion. In contrast less than 13% of nurses and midwives of the Netherlands and Switzerland reported high levels of emotional exhaustion. A further 33.2% of Irish nurses reported medium levels of emotional exhaustion (Scott et al. 2011).
- The same RN4CAST project found that only 22.4% somewhat or strongly agreed that there were enough staff members to get the work done (Scott et al. 2011, p.5).

Skill mix: the contribution of Registered Nurses

- A four-year study of data from 13 US military hospitals found that an increased proportion of registered nurses in the skill mix was associated with fewer needlestick injuries across all three types of units studied: medical-surgical, step-down and critical care. The study also found that a decrease in nursing care hours per patient shift was associated with increased needlestick injuries (Patrician, Pryor, et al. 2011).
- Regardless of the quality of the work environment, a study looking at data from over 1 million patients from 665 hospitals in the USA has found that a 10% increase in the number of Bachelor of Science in Nursing Degree nurses resulted in roughly a 4% decrease in the likelihood of death or failure-to-rescue (Aiken et al. 2011).
-

² Emotional exhaustion was measured using the Maslach Burnout Inventory.

- An article examining the use of reduced nurse staffing in favour of less skilled personnel in US trauma centers examined data from over 70,000 patients admitted to 77 trauma centers. Controlling for patient risk factors and the hospital characteristics, it found that a 1% increase in the ratio of licensed practical nurse (LPN) to total nursing time was associated with a 4% increase in the odds of mortality (Glance et al. 2012).
- An earlier study in the USA found that there was evidence that greater numbers of registered nurse hours or licensed nurse hours were associated with a shorter length of stay among medical patients and lower rates of failure to rescue among surgical patients (Needleman et al. 2002).
- A higher percentage of baccalaureate nurses was found to be strongly related to better patient outcomes in a Chinese study. Each 10% increase in the percent of nurses with a baccalaureate qualification was related with increased patient satisfaction, high ratings, and willingness to recommend their hospital by factors ranging from 1.11 to 1.13 (Teng et al. 2010).

Case Study: Poor staffing is one of the three key factors in poor quality of services and impact on dignity and respect in adult social care provision according to the Care Quality Commission

On the 22 November 2012 the Care Quality Commission (CQC) published its most comprehensive 'State of Care' report. The report examines all care sectors for the first time and explores why some care services are failing to meet CQC standards.

With an increase in the number of people with complex or multiple illnesses, and the rising numbers of older people with dementia, the report notes a growing demand for nursing care within social care settings. This is reflected in an increase in the number of nursing homes registered with CQC in 2011/12 (the total rose by 1.4% [64 nursing homes] with a 3.3% increase in the number of registered nursing home beds). At the same time, the number of residential (non-nursing) care homes is falling.

Based on the evidence of over 13,000 inspections, the report suggests that pressures on care services are increasing the risks of poor or unsafe care for people who are less able to speak up for themselves and those, who as a result of their circumstances, are more vulnerable.

The report concludes that in some areas staffing and skill mix issues, combined with the need to care for people with increasingly complex conditions, are beginning to affect the quality of care being delivered, with a particular impact on the dignity and respect of people.

Where services fail, CQC has found three common factors which contribute to the poor quality of services:

- 1. Providers who try to manage with high vacancy rates or wrong mix of skills.*
- 2. An attitude to care that is 'task-based', not person-centred.*
- 3. A care culture in which the unacceptable becomes the norm.*

Ensuring there are enough staff to provide a good service is a significant issue in many services. Of the 2,031 nursing homes CQC inspected, 23% (equates to 467 inspections) were not meeting the CQC standard of having adequate staffing levels, whilst 16% (equates to 603 inspections) of the 3,771 residential care homes CQC inspected were not meeting the same CQC standard. In the NHS, 16% of 250 inspections of hospital services (equates to 40 inspections) failed to meet the standard.

The increased pressures on care providers are also impacting on CQC standards – such as record-keeping and the management of medicines - that can be tell-tale signs of possible future problems of poor care (CQC 2012)

The is available at www.cqc.org.uk/stateofcare2012

Bibliography

- Aiken, L.H. et al., 2011. Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Medical Care*, 49(12), pp.1047–53. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21945978> [Accessed November 13, 2012].
- Aiken, L.H. et al., 2010. Implications of the California nurse staffing mandate for other states. *Health Services Research*, 45(4), pp.904–21. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2908200&tool=pmcentrez&rendertype=abstract> [Accessed November 5, 2012].
- Ausserhofer, D. et al., 2012. The association of patient safety climate and nurse-related organizational factors with selected patient outcomes: A cross-sectional survey. *International journal of nursing studies*, null(null). Available at: <http://dx.doi.org/10.1016/j.ijnurstu.2012.04.007> [Accessed November 13, 2012].
- Berry, L. & Curry, P., 2012. *Nursing workload and patient care*, Available at: http://www.nursesunions.ca/sites/default/files/2012.10.04_workload_popular_english.pdf.
- Bobay, K. et al., 2011. Outcomes and Cost Analysis of the Impact of Unit-Level Nurse Staffing. *Nursing Economics*, 29(2).
- Care Quality Commission, (2012) The state of health care and adult social care in England in 2011/12. The Stationery Office, London. Available at: www.cqc.org.uk/stateofcare2012.
- Cho, S.-H. et al., 2003. The effects of nurse staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Research*, 52(2), pp.71–9. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/12657982>.
- Cho, S.-H., Hwang, J.H. & Kim, J., 2008. Nurse Staffing and Patient Mortality in ICU. *Nursing Research*, 57(5), pp.322–330. Available at: http://journals.lww.com/nursingresearchonline/Abstract/2008/09000/Nurse_Staffing_and_Patient_Mortality_in_Intensive.4.aspx [Accessed November 13, 2012].
- Cimiotti, J.P. et al., 2012. Nurse staffing, burnout, and health care-associated infection. *American Journal of Infection Control*, 40(6), pp.486–90. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22854376> [Accessed November 12, 2012].
- Dall, T.M. et al., 2009. The economic value of professional nursing. *Medical Care*, 47(1), pp.97–104. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/19106737>.
- Department for Professional Employment, 2003. The Aiken Study: Hospital Nurse Staffing and Patient Mortality, Nurse Burnout and Job Dissatisfaction. , 20(August 2002), pp.2–3.
- Diya, L. et al., 2012. The relationship between in-hospital mortality, readmission into the intensive care nursing unit and/or operating theatre and nurse staffing levels. *Journal of Advanced Nursing*, 68(5), pp.1073–81. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21883408> [Accessed November 13, 2012].
- Duffield, C et al., *Nursing workload and staffing: impact on patients and staff*,
- Dunton, Nancy et al., 2004. Nurse Staffing and patient falls. *Nursing Outlook*, 52(1), pp.53–9. Available at: [http://www.nursingoutlook.org/article/S0029-6554\(03\)00230-6/abstract](http://www.nursingoutlook.org/article/S0029-6554(03)00230-6/abstract) [Accessed November 13, 2012].

- Dunton, NE et al., 2007. The Relationship of Nursing Workforce Characteristics to Patient Outcomes. *The Online Journal of Issues in Nursing*, 12(3). Available at: <http://nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume122007/No3Sept07/NursingWorkforceCharacteristics.html> [Accessed November 13, 2012].
- Frith, K.H., Anderson, E.F. & Fong, E.A., 2012. Nurse Staffing Is an Important Strategy to Prevent Medication Errors in Community Hospitals. *Nursing Economics*, 30(5), pp.288–294.
- Glance, L.G. et al., 2012. The association between nurse staffing and hospital outcomes in injured patients. *BMC Health Services Research*, 12(1), p.247. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3444311&tool=pmcentrez&rendertype=abstract> [Accessed November 13, 2012].
- Hugonnet, S., Uçkay, I. & Pittet, D., 2007. Staffing level: a determinant of late-onset ventilator-associated pneumonia. *Critical Care*, 11(4), p.R80. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2206525&tool=pmcentrez&rendertype=abstract> [Accessed November 13, 2012].
- Kalisch, B.J., Tschannen, D. & Lee, K.H., 2012. Missed nursing care, staffing, and patient falls. *Journal of Nursing Care Quality*, 27(1), pp.6–12. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21738057> [Accessed November 13, 2012].
- Kane, R.L. et al., 2007. The Association of Registered Nurse Staffing Levels and Patient Outcomes: Systematic Review and Meta-Analysis. *Medical Care*, 45(12), pp.1195–1204.
- Kutney-Lee, A. et al., 2009. Nursing: a key to patient satisfaction. *Health Affairs*, 28(4), pp.w669–77. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2718727&tool=pmcentrez&rendertype=abstract> [Accessed November 13, 2012].
- Lake, E. et al., 2010. Patient falls: association with hospital Magnet status and nursing unit staffing. *Research in Nursing & Health*, 33(5), pp.413–425. Available at: <http://onlinelibrary.wiley.com/doi/10.1002/nur.20399/full> [Accessed November 13, 2012].
- Liang, Y.-W. et al., 2012. Nurse staffing, direct nursing care hours and patient mortality in Taiwan: the longitudinal analysis of hospital nurse staffing and patient outcome study. *BMC Health Services Research*, 12(1), p.44. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3305633&tool=pmcentrez&rendertype=abstract> [Accessed November 13, 2012].
- Needleman, J. et al., 2011. Nurse staffing and inpatient hospital mortality. *The New England Journal of Medicine*, 364(25), p.2468; author reply 2469. Available at: <http://www.nejm.org/doi/full/10.1056/NEJMsa1001025> [Accessed November 13, 2012].
- Needleman, J. et al., 2002. Nurse-staffing levels and the quality of care in hospitals. *The New England Journal of Medicine*, 346(22), pp.1715–22. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/12037152>.
- Page, A., 2004. *Keeping Patients Safe: Transforming the Work Environment of Nurses*, National Academies Press.
- Park, S.H. et al., 2012. Patient Turnover and the relationship between nurse staffing and patient outcomes. *Research in Nursing and Health*, 35(3), pp.277–88. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/22457013> [Accessed November 13, 2012].

- Patrician, P.A., Pryor, E., et al., 2011. Needlestick injuries among nursing staff: Association with shift-level staffing. *American Journal of Infection Control*, August(6), pp.477–82. Available at: [http://www.ajicjournal.org/article/S0196-6553\(10\)00994-6/abstract](http://www.ajicjournal.org/article/S0196-6553(10)00994-6/abstract) [Accessed November 13, 2012].
- Patrician, P.A., Loan, L., et al., 2011. The association of shift-level nurse staffing with adverse patient events. *Journal of Nursing Administration*, 41(2), pp.64–77. Available at: http://journals.lww.com/jonajournal/Abstract/2011/02000/The_Association_of_Shift_Level_Nurse_Staffing_With.5.aspx [Accessed November 15, 2012].
- Rafferty, A.-M. et al., 2007. Outcomes of variation in hospital nurse staffing in English hospitals; Cross-sectional analysis of survey data and discharge records. *International Journal of Nursing Studies*, 44(2), pp.175–182.
- Scott, A. et al., 2011. *RN4CAST project , Ireland Summary Report*,
- Stony Brook Medicine, Adverse Event Information. Available at: <http://indigo.gcrc.sunysb.edu/aeinfo.aspx> [Accessed November 19, 2012].
- Teng, C.-I. et al., 2010. Interactive effects of nurse-experienced time pressure and burnout on patient safety: a cross-sectional survey. *International Journal of Nursing Studies*, 47(11), pp.1442–50. Available at: [http://www.journalofnursingstudies.com/article/S0020-7489\(10\)00146-X/abstract](http://www.journalofnursingstudies.com/article/S0020-7489(10)00146-X/abstract) [Accessed November 12, 2012].
- Thungjaroenkul, P. & Cummings, G.G., 2007. The Impact of Nurse Staffing on Hospital Costs and Patient Length of Stay: *Nursing Economics*, 25(5), pp.255–265.
- Trinkoff, A.M. et al., 2011. Nurses' Work Schedule Characteristics, Nurse Staffing, and Patient Mortality. *Nursing Research*, 60(1), pp.1–8. Available at: http://journals.lww.com/nursingresearchonline/Abstract/2011/01000/Nurses__Work_Schedule_Characteristics,_Nurse.1.aspx [Accessed November 13, 2012].
- Tschannen, D. & Kalisch, B.J., 2008. The effect of variations in nurse staffing on patient length of stay in the acute care setting. *Western Journal of Nursing Research*, 31(2), pp.153–70. Available at: <http://wjn.sagepub.com/content/31/2/153.abstract?etoc> [Accessed November 13, 2012].
- Twigg, D. et al., 2010. The impact of nurses on patient morbidity and mortality - the need for a policy change in response to the nursing shortage. *Australian Health Review*, 34(3), pp.312–6. Available at: http://www.publish.csiro.au/view/journals/dsp_journal_fulltext.cfm?nid=270&f=AH08668 [Accessed November 13, 2012].
- University of Michigan School of Public Health, epiCentral: Michigan Center for Public Health Preparedness. Available at: http://practice.sph.umich.edu/micphp/epicentral/odds_ratio.php [Accessed November 19, 2012].
- You, L.-M. et al., 2012. Hospital nursing, care quality, and patient satisfaction: Cross-sectional surveys of nurses and patients in hospitals in China and Europe. *International Journal of Nursing Studies*, null(null). Available at: <http://dx.doi.org/10.1016/j.ijnurstu.2012.05.003> [Accessed November 13, 2012].

Glossary of terms

Adverse event	An adverse event any unfavorable and unintended sign including an abnormal laboratory finding, symptom or disease associated with the use of a medical treatment or procedure, regardless of whether it is considered related to the medical treatment or procedure(Stony Brook Medicine n.d.)
Failure to rescue	Mortality preceded by a hospital-acquired complication (e.g. pneumonia, sepsis, renal failure)(Park et al. 2012)
Odds ratio	An odds ratio (OR) is defined as the ratio of the odds of an event occurring in one group to the odds of it occurring in another group, or to a data-based estimate of that ratio. An odds ratio estimates the probability of disease given exposure to a specific factor by measuring the probability of exposure given the presence of disease(University of Michigan School of Public Health n.d.)